Iliac vein reconstructions to treat acute and chronic venous occlusive disease

Y. S. Alimi, MD, P. DiMauro, MD, D. Fabre, MD, and C. Juhan, MD,
Marseille, France

Purpose: **The treatment of permanent and benign iliac vein occlusion responsible for acute vein thrombosis or chronic symptoms remains controversial. Different methods of reconstruction using a reinforced expanded polytetrafluoroethylene bypass graft associated with an arteriovenous fistula and their intermediate-term results are analyzed.**

Methods: **Eight consecutive patients (six men, two women; mean age, 45.6 years; range, 29 to 70 years) were treated over a period of 38 months for iliac vein obstruction. Three short bypass procedures between the left iliac vein and the right common iliac vein with temporary arteriovenous fistulas were carried out after an iliofemoral (and caval in two cases) venous thrombectomy, which revealed May-Thurner syndrome (n = 1) and a compression of the left common iliac vein by the left hypogastric artery (n = 2). Five long bypass procedures (one femorofemoral, two left common femoral–vena caval, one right superficial femoral–common iliac, and one bifemorocaval) with a definitive arteriovenous fistula were performed for long chronic venous occlusion in four cases (responsible for venous claudication [n = 3], recurrent ulcers [n = 1]) and after iatrogenic ligature of the left external iliac vein during total cystectomy with double ureterostomy in one case.**

Results: **There was no evidence of pulmonary embolism, and no deaths were recorded in the perioperative period. Two patients had an early bypass thrombectomy, but one returned with a further graft occlusion. Seven grafts remained patent after a mean follow-up of 19.5 months (range, 10 to 45 months). One successful thrombectomy was necessary during the twenty-third postoperative month.**

Conclusions: **Reconstruction of iliac veins in case of permanent compression, mostly discovered after venous thrombectomy, or for selected patients with symptomatic benign iliac vein occlusion, is safe and provides good intermediate-term results. (J Vasc Surg 1997;25:673-81.)**

In the early 1980s, several experimental studies showed good preliminary results after replacement of the inferior vena cava (IVC) or the iliac veins using externally supported expanded polytetrafluoroethylene (ePTFE) grafts and distal arteriovenous fistulas.[1-3] Since that period, series of venous reconstructions have been rare, and meaningful evaluation of long-term patency of venous grafts remains difficult.[4-7] Our experience in venous thrombectomy concerning iliofemoral and IVC venous thrombosis led us to discover a permanent iliac venous compression after clot removal in four cases.[8-10] To avoid recurrence of deep venous thrombosis (DVT), we decided to treat anatomical anomalies responsible for iliac venous compression by using prosthetic bypass grafts. At the same time, chronic nonmalignant IVC or iliac obstructions responsible for ulcers or venous claudication were treated in the same way in four other cases. This article is a review of this clinical experience.

From the Department of Vascular Surgery, Hôpital Nord.
Reprint requests: Yves Alimi, MD, Department of Vascular Surgery, Hôpital Nord, Chemin des Bourrellys, 13915 Marseille Cedex 20, France.

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MATERIAL AND METHODS

Between February 1, 1992, and March 30, 1995, eight consecutive patients (six men, two women; mean age, 45.6 years; range, 29 to 70 years) underwent venous bypass grafting for the reconstruction of iliac veins. Preoperative and postoperative clinical symptoms are exposed according to the clinical classification scheme suggested by the Subcommittee on Reporting Standards in Venous Disease.[11]

Acute vein obstruction

Acute vein obstruction was present in four patients (Table I). In three patients, a left iliac vein

Table I. Acute inferior vena cava and iliac vein obstructions

Case no.	*Age*	*Sex*	*Initial findings*	*Cause*	*Date of surgery (day after venous thrombectomy)*	*Type of graft*	*Location of graft*	*Last imaging*	*Clinical outcome (classification)*
1	29	M	Left tibial-popliteal-femoral-iliac-IVC DVT (venous thrombectomy)	Cockett/May-Thurner syndrome	July 1993 (D31)	Reinforced ePTFE (14 mm)	Left common iliac; right common iliac and temporary AV fistula	Patent at 11 mo	Asymptomatic (+3)
2	70	M	Phlegmasia cerulea dolens Left tibial-popliteal-femoral-iliac-DVT (venous thrombectomy)	Compression of left common iliac vein by left internal iliac artery	June 1994 (D5)	Reinforced ePTFE (12 mm)	Left external iliac; right common iliac and temporary AV fistula	Patent at 20 mo	Asymptomatic (+3)
3	40	M	Pulmonary embolism and left tibial-popliteal-femoral-iliac-IVC DVT (venous thrombectomy)	Compression of left common iliac vein by left internal iliac artery	Mar. 1995 (D19)	Reinforced ePTFE (14 mm)	Left external iliac; right common iliac and temporary AV fistual	Patent at 12 mo	Asymptomatic (+3)
4	51	M	Phlegmasia cerulea dolens - venous gangrene - renal insufficiency	Accidental ligation of left external iliac vein during cystectomy (cancer)	Mar. 1995	Reinforced ePTFE (10 mm)	Left common femoral; right common femoral and definitive AV fistula–aponevrotomy	Patent at 12 mo	Steppage gait (resection of anterior compartment); normal renal function (+2)

AV, Arteriovenous.
*+3, Asymptomatic; +2/+1, modeate or mild improvement; 0, unchanged; −1/−2/−3, mild, significant, or marked worsening.

obstruction was discovered after occurrence of recent (1 to 5 days) and extensive DVT. Patient 1 had a painful swelling left leg and thigh after a month's rest to recover from a skull trauma with no cerebral complication. This 29-year-old man underwent a color-coded duplex scan and an ascendant venographic examination with a transfemoral iliocavographic examination that identified DVT extending from the infrapopliteal veins to the common iliac vein associated with a free clot in the IVC. A computed tomographic (CT) scan with injection was also performed to see the distal part of the clot located in the IVC and to eliminate iliocaval extrinsic compression. An emergency IVC and an iliofemoral venous thrombectomy were carried out through an abdominal transperitoneal approach and a left groin approach. An arteriovenous fistula was created using the last 5 cm of the greater saphenous vein, which was implanted on the superficial femoral artery by conserving the saphenofemoral junction.[8-10] An unusually painful swelling leg was still present during the immediate postoperative period and was found to be related to intolerance of the arteriovenous fistula. A fistulographic examination was rapidly performed and showed severe May-Thurner syndrome,[12] with no important collateral venous circulation and no retrograde opacification of the superficial or profunda femoral veins that attest for persistent competent valves. Thirty-one days after the venous thrombectomy, the patient underwent operation again. Through an abdominal transperitoneal approach, intraoperative findings confirmed total and chronic compression of the distal common iliac vein even though the right common iliac artery had been freed. A bypass graft using a 14 mm reinforced ePTFE tube was implanted between the proximal left common iliac vein and the right common iliac vein, conserving the arteriovenous fistula previously performed at the groin during venous thrombectomy.

Patient 2 was a 70-year-old man who was admitted to the emergency ward for a phlegmasia cerulea dolens of the left limb. A color-coded duplex scan and an ascendant venogram identified DVT extending from the tibial veins to the common iliac vein. An iliofemoral venous thrombectomy was immediately carried out through a groin approach, and an arteriovenous fistula was created as described for patient 1. Persistence of an unusual painful swelling leg during the immediate postoperative period associated with a dysfunctioning arteriovenous fistula with a slightly audible thrill led us to obtain a fistulogram. A tight compression of the proximal section of the left common iliac vein by the left hypogastric artery was noted and did not disappear despite a large dissection

of the left iliac artery bifurcation performed 5 days after the venous thrombectomy. The patient underwent bypass grafting by means of a 12 mm reinforced ePTFE tube between the distal left external iliac vein and the right common iliac vein, conserving the arteriovenous fistula previously performed at the groin.

Patient 3 was transferred to our department for recent pulmonary embolism and left-limb DVT that had arisen 2 weeks after a minor industrial injury. Venous explorations showed extensive DVT from the tibial veins to the common iliac vein with a clot in the IVC confirmed by transfemoral iliocavogram and CT scan (Fig. 1). This 40-year-old patient underwent an IVC and iliofemoral venous thrombectomy through an abdominal transperitoneal and a left groin approach, with creation of an arteriovenous fistula as described earlier. The postoperative fistulogram showed a tight compression of the proximal section of the left common iliac vein by the left hypogastric artery. To avoid recurrence of iliac DVT, a bypass graft using a 14 mm reinforced ePTFE tube was then implanted on the nineteenth day after surgery between the distal left external iliac vein and the right common iliac vein, conserving the arteriovenous fistula previously performed at the groin.

Six to 8 weeks after implantation of the short bypass grafts, patients 1, 2, and 3 underwent surgical ligature and division of the arteriovenous fistula under general anesthesia.

Patient 4 was in the intensive care unit for a phlegmasia cerulea dolens with venous gangrene and compartment compression syndrome of the left leg, associated with renal insufficiency (creatinine level, 7.7 mg/dl); this occurred 24 hours after accidental ligature of the left external iliac vein during a total cystectomy with double ureterostomy for cancer. A crossover bypass using a 10 mm reinforced ePTFE graft was immediately implanted between the left and the right common femoral veins in a subcutaneous passage. A long-standing arteriovenous fistula, using the last 10 cm of the greater saphenous vein, was implanted between the proximal superficial femoral artery, and a hole 3 to 4 mm in diameter was made in the first 3 or 4 centimeters of the graft after partial resection of the corresponding rings, as described by Sottiurai.[13]

Chronic vein obstruction

Chronic vein obstruction was present in four patients (Table II). Patient 5 was a 41-year-old woman who had persistent venous claudication of the left limb and lower extremity swelling (class 4). These symptoms had been present for 7 years despite strict medical treatment with elastic compression, leg elevation, and frequently, treatment with diuretics. Preoperative evaluation included routine history and physical and laboratory examination associated with a pelvic and abdominal CT scan to avoid extrinsic venous compression (such as benign or malignant tumor). In addition, a color-coded duplex scan and an ascending contrast venogram with transfemoral iliocavographic examination were obtained and showed chronic left iliac vein occlusion, whereas the left popliteal and femoral veins were patent with competent venous valves. The gradient between the right and left common femoral vein, evaluated by direct comparative venous pressure measurement, was 3 mm Hg at rest and when supine and 4 mm Hg during Valsalva's maneuver. In the standing position, the resting interfemoral gradient was 4 mm Hg, up to 7 mm Hg during Valsalva's maneuver, and to 10 mm Hg after 20 extensions of the ankles. During surgery, an 8 mm reinforced ePTFE graft was placed between the left common femoral vein and the IVC through an abdominal transperitoneal approach, with a long-standing femoral arteriovenous fistula.

Patient 6 was admitted to our department for recurrent ankle ulcers predominant in the left leg, which had evolved for 5 years despite medical treatment (class 6). Twenty years beforehand, this 38-year-old man had had a neurologic trauma that was responsible for a limp and was followed by DVT of the left leg. Color-coded duplex scan and an ascendant venogram with transfemoral iliocavographic examination showed a bilateral iliac and IVC obstruction extending to the renal veins. To visualize the IVC proximal to the obstruction, an upper cavographic examination was performed with contrast injection into the suprarenal IVC through an arm vein catheter. A right femorocaval (above renal veins) bypass grafting procedure was performed by means of a 14 mm reinforced ePTFE graft and a right femoral arteriovenous fistula. This graft was connected to a 12 mm bypass implanted on the left femoral vein with a left femoral arteriovenous fistula (Fig. 2).

Patient 7 had persistent venous claudication of the left limb and lower extremity swelling that elastic compression and leg elevation did not improve (class 4). Three years earlier, this 42-year-old woman had had left DVT extending from the superficial femoral vein to the common iliac vein. Recent venous explorations identified chronic left iliac thrombosis with patent femoral veins that were the site of moderate postthrombotic lesions. Direct comparative venous

Fig. 1. A, Ascendant venogram, transfemoral iliocavogram, and CT scan show acute DVT extending from infrapopliteal veins to inferior vena cava.

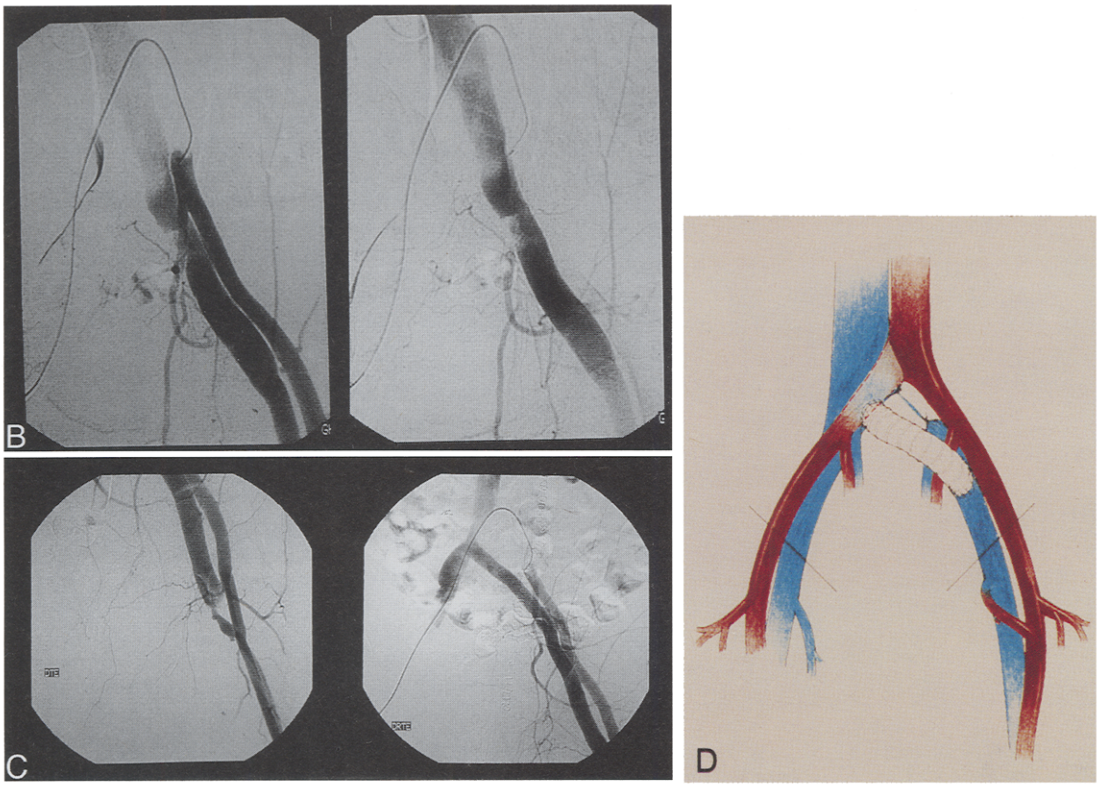

Fig. 1. B, Fistulogram performed 2 days after venous thrombectomy with creation of temporary arteriovenous fistula at groin shows tight compression of proximal left iliac vein by left internal iliac artery. **C,** Short reinforced ePTFE bypass graft placed between left external iliac vein and right common iliac vein conserving initial arteriovenous fistula and controlled by postoperative fistulography. **D,** Scheme of bypass and of temporary arteriovenous fistula created with last centimeters of great saphenous vein, implanted in superficial femoral artery.

pressure measurement between the left and the right common femoral veins resulted in gradients of 4 mm Hg at rest when supine and 7 mm Hg during Valsalva's maneuver. In the standing position, the resting interfemoral gradient was 5 mm Hg, up to 9 mm Hg during Valsalva's maneuver, and to 13 mm Hg after 20 extensions of the ankles. A 10 mm reinforced ePTFE graft was placed between the left common femoral vein and the IVC through an abdominal transperitoneal approach, with a long-standing femoral arteriovenous fistula.

Patient 8 was a 54-year-old man who had sustained a penetrating trauma of the right common femoral and external iliac veins 30 years beforehand. He had complained of venous claudication of the right leg and of lower extremity swelling during evening hours despite medical treatment (class 4). Venous explorations revealed chronic occlusion from the last third of the superficial femoral vein to the external iliac vein, with competent popliteal and proximal superficial femoral venous valves. This patient underwent placement of a 10 mm reinforced ePTFE bypass graft between the right superficial femoral vein through Hunter's canal and the right common iliac vein through an abdominal retroperitoneal approach, associated with a popliteal arteriovenous fistula.

All arteriovenous fistulas created in patients 5, 6, 7, and 8 were definitive and constructed as described for patient 4.

During construction of the venous bypass, treatment with a bolus of 70 IU/kg of unfractionated heparin (UFH) was started immediately before venous cross-clamping. Two hours after the end of the operation, an intravenous perfusion of UFH was given to obtain an activated partial thromboplastin time (APTT) between 60 and 70 seconds over a period of at least 72 hours. Patients then received adequate subcutaneous injections of UFH three times a day and began taking warfarin on the seventh or eighth day after surgery.

Table II. Chronic inferior vena cava and iliac vein obstructions

Case no.	*Age*	*Sex*	*Cause*	*Date of surgery*	*Type of graft*	*Location of graft*	*Last imaging*	*Clinical outcome*	*Clinical classification*	
									*Pre-operative**	*Post operative†*
5	41	F	Left iliac DVT	Feb. 1992	Reinforced ePTFE (8 mm)	Left common femoral; IVC and definitive AV fistula	Patent at 45 mo	Minimal symptoms	4	+2
6	38	M	Left and right iliac - IVC DVT	Jan. 1994	Reinforced ePTFE (12 and 14 mm)	Bifemorocaval and definitive AV fistula	Patent at 26 mo	Swelling decreased; ulcer healed	6	+1
7	42	F	Left iliac DVT	Nov. 1994	Reinforced ePTFE (10 mm)	Left common femoral; IVC and definitive AV fistula	Occluded after surgery	No change	4	0
8	54	M	Right common femoral and external iliac DVT (post-trauma)	Nov. 1994	Reinforced ePTFE (10 mm)	Right superficial femoral; right common iliac and definitive AV fistula	Patent at 10 mo	Asymptomatic; death at 11 mo (unknown reason)	4	+3

AV, Arteriovenous.
*0, Asymptomatic; 1, telangiectase; 2, varicose veins; 3, edema; 4, skin changes; 5, healed ulceration; 6, active ulceration.
†+3, Asymptomatic; +2/+1, moderate or mild improvement; 0, unchanged; −1/−2/−3, mild, significant, or marked worsening.

RESULTS

Early results (<30 days). There was no evidence of pulmonary embolism, and no deaths were recorded. There were five secondary surgical procedures. Patient 7 had a graft thrombosis on day 2, and despite an early graft thrombectomy a definitive rethrombosis occurred on day 11; no abnormalities of coagulability examinations and no anatomic findings were noticed in this case. Thrombosis of the arteriovenous fistula with a patent graft on day 4 in patient 8 was treated with a successful thrombectomy. Thrombosis of the graft and of the arteriovenous fistula on day 4 in patient 3 required a graft thrombectomy and refection of the arteriovenous fistula by replacing the saphenous vein with a 5 mm ePTFE graft. Furthermore, evacuation of a retroperitoneal hematoma on day 3 in patient 5 and resection of the muscles of the anterior compartment of the left leg after venous gangrene on day 21 in patient 4 were carried out. Consequently, all grafts but one (patient 7) remain patent as confirmed by a fistulographic examination performed systematically before discharge, through puncture of the contralateral femoral artery and placement of a catheter upstream in the arteriovenous fistula.

Late results. The mean follow-up was 19.5 months and ranged from 10 to 45 months. Patient 8 died of an unknown cause (no evidence of pulmonary embolism) 11 months after implantation of a right femoral-iliac bypass with a patent graft. One false aneurysm on the graft implantation of the arteriovenous fistula associated with thrombosis of the femorofemoral section of the bifemorocaval bypass occurred in patient 6 and was treated by thrombectomy of the graft and refection of the arteriovenous fistula during the 23rd postoperative month. One totally asymptomatic patient with a patent graft was lost to follow-up after 11 months (patient 1).

The four patients who were treated for acute vein obstruction had a good postoperative outcome at the end of follow-up, with a patent graft confirmed both by clinical examination and by color-coded duplex scanning. Patients 1, 2, and 3 remain asymptomatic after 11, 20, and 12 months, respectively; after 12 months, patient 4 had normal renal function and a steppage gait as a result of resection of the anterior compartment of the left leg, which healed well.

Among the four patients who were treated for chronic vein obstruction, patient 7 had early recurrent graft thrombosis associated with relapsing of venous claudication and leg swelling. Patients 5, 6, and 8 had patent grafts at the end of follow-up confirmed both by physical examination, during which the thrill of the arteriovenous fistula was controlled, and by color-coded duplex scanning after 45, 26, and 10 months, respectively. Venous claudica-

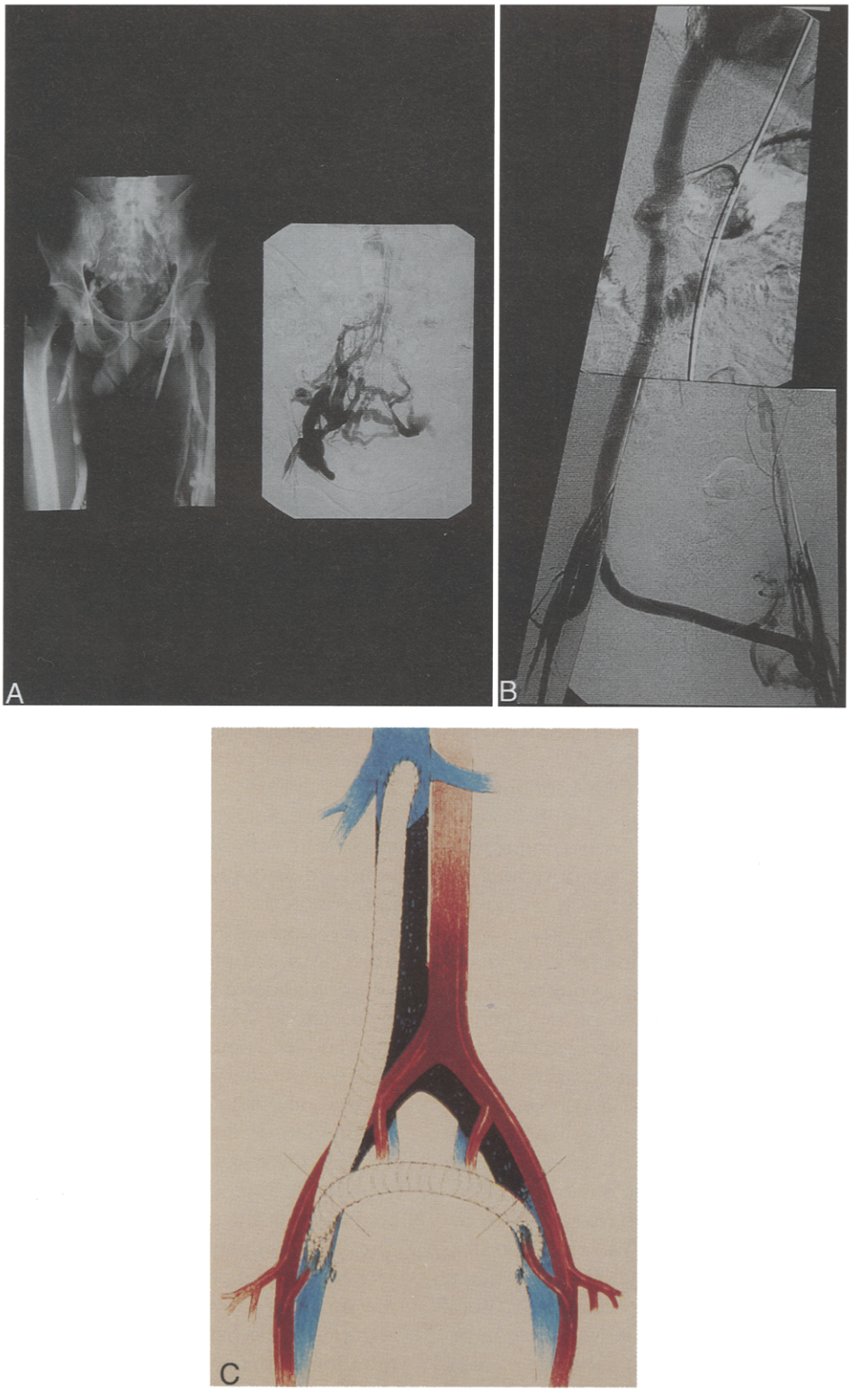

Fig. 2. A, Ascendant venogram and transfemoral iliocavogram show occlusion of bilateral iliac veins and of inferior vena cava extending to renal veins. **B,** Fistulogram obtained 5 days after implantation of long right femorocaval reinforced ePTFE bypass graft with definitive right femoral arteriovenous fistula associated with cross-pubic femorofemoral venous bypass graft with definitive left femoral arteriovenous fistula. **C,** Scheme of bypass and of left and right definitive arteriovenous fistulas using last centimeters of great saphenous vein and implanted between superficial femoral artery and a hole of 3 to 4 mm in diameter carried out in first section of graft.

tion disappeared in patients 8 and 5, with persistence of mild leg swelling during evening hours in patient 5. Patient 6, who was treated for recurrent ankle ulcers by a bifemorocaval bypass procedure, had a totally healed leg after 6 months, with persistence of a mild swelling of the left leg. All patients with a patent graft are currently taking warfarin with a regularly controlled international normalized ratio (INR) between 2 and 3.

DISCUSSION

Reconstructions of IVC and iliac veins are reputed to be difficult because of several factors responsible for failure: low pressure and low flow of the venous system, competitive collateral venous circulation in case of chronic venous obstruction, external compression of the graft by increased abdominal pressure, or in tightly confined space such as the area under the inguinal ligament.[1,4,6,14] This difficulty may explain the lack of large series of venous reconstruction with long-term follow-up. Nevertheless, experimental studies and increasing clinical experience have allowed important progress in preoperative evaluation and patient selection, improvement in surgical technique, availability of large reinforced prosthetic grafts, systematic use of a distal arteriovenous fistula, perioperative and postoperative anticoagulation, and postoperative surveillance.[2-5]

Our large experience of more than 130 iliofemoral and IVC venous thrombectomies led us in some instances to discover severe iliac vein compression responsible for intolerance of the arteriovenous fistula performed at the groin.[8-10] A few years ago we decided to treat these lesions, and in the present series early postoperative fistulographic examination identified a tight May-Thurner syndrome in one case[12] and compression of the proximal section of the common left iliac vein by the left internal iliac artery in two cases. Two other cases of this latter lesion had already been described by David et al.[15] in 1981 and by Steinberg and Jacobs[16] in 1993, and was treated by division of the left hypogastric artery associated with an enlargement of the iliac vein by a venous patch in one case.

To avoid recurrent DVT, we have started to bypass the anatomical anomalies with an ePTFE graft as early as possible, thus obtaining good postoperative results. This might be a result of persistence of good tibial-popliteal-femoral venous inflow with competent valves after thrombectomy and absence of competitive collateral venous circulation. We did not consider a direct reconstruction using a patch because we thought that intimal inflammatory lesions after thrombosis and thrombectomy in addition to venous webs may cause early occlusion of a direct reconstruction. For the same reasons, and because in two of these cases compression of the proximal part of the common iliac vein behind the hypogastric artery would only allow the use of the external iliac vein, transposition of the left iliac vein to the right side as proposed by Kistner[17] was not performed. The use of an ePTFE bypass graft had already been mentioned by Comerota et al.,[18] who performed a cross-pubic venous bypass in three cases with residual iliofemoral obstruction after venous thrombectomy, lysis, or both; two bypass grafts remained patent after 40 and 63 months. Nevertheless, large series of femorofemoral cross-over bypass procedures that show moderate long-term patency rates enabled us to try anatomic venous reconstructions using a short, wide, reinforced ePTFE bypass,[5,19] as mentioned by Gloviczki et al.[6]

Chronic iliocaval venous thrombosis mainly set a difficult problem of indication; patients with typical disabling symptoms such as chronic swelling of the leg, venous claudication, or stasis ulcers persisting several years past the acute episode and after several months of medical treatment should be evaluated for reconstruction. Detailed assessment of the venous anatomy of the leg, pelvis, and abdomen with contrast venography is mandatory. Good prognostic criteria are low-risk patients, without significant reflux in the femoropopliteal veins, with an unaltered external iliac or common femoral vein suitable for a proximal anastomosis, and a normal vena cava or a contralateral iliac vein used as outflow. Several authors underlined the interest of the pressure gradient: Gloviczki et al.[6] stressed a pressure gradient of at least 5 mm Hg, measured distal and proximal to the obstruction, whereas Gruss[5] considered the resting femoral pressure doubled after exercise. Measurement of the gradient between right and left common femoral veins in different situations was possible in only two of our four chronic cases, because one had an extended DVT of the superficial and common femoral veins and the other had a bilateral iliac vein thrombosis.

An arteriovenous fistula was systematically created either at the end of surgery or by conserving the one carried out after venous thrombectomy to avoid early thrombosis of the graft implanted in the low-pressure venous system and to improve intermediate-term results, as has been shown.[1] The technique and duration of the arteriovenous fistula remain controversial: a 4 to 5 mm PTFE graft, a large proximal branch of the greater saphenous vein, or the proximal greater saphenous vein itself can be used, and several authors recommend closing it by surgical ligature or by endovascular balloon occlusion after 6

to 8 weeks to prevent hemodynamic consequences.[20-22] In this series, two different methods of arteriovenous fistula were created.

Concerning the three less thrombogenic anatomic short bypass procedures carried out after venous thrombectomy, we decided to close the arteriovenous fistula after 6 to 8 weeks to avoid long-term hemodynamic complications that may occur in relation with dilation of the greater saphenous vein, the saphenofemoral junction, or both. In the other five cases, the crural section of the greater saphenous vein was implanted between the proximal superficial femoral artery and a hole of 3 to 4 mm in diameter created in the first 3 or 4 cm of the graft after partial resection of the corresponding rings, as described by Sottiurai et al.[13] This is supposed to maintain better patency of long venous bypasses and provide a controlled nonprogressive arteriovenous fistula that requires no future ligature. Because two early (patients 3 and 7) and one late (patient 6) graft thrombosis occurred in our series, we think that further experimental and clinical studies would be necessary.

CONCLUSION

Direct reconstruction of iliac vein obstruction with a large-diameter, reinforced ePTFE graft, associated with a temporary or definitive distal arteriovenous fistula is safe and provides good intermediate-term results. Our modest but continuously increasing experience allows us to recommend this procedure in case of permanent compression of iliac veins discovered mainly after venous thrombectomy or lysis or for selected patients with symptomatic benign iliac vein obstruction.

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